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PREPARED FOR THE
HUMAN ENGINEERING LABORATORY

BY

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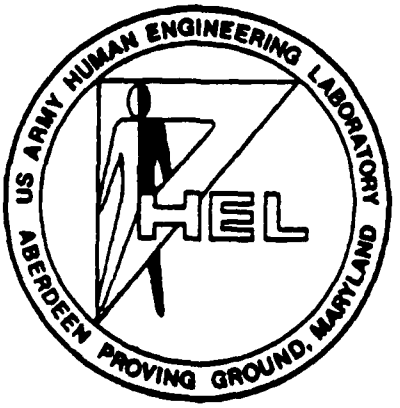
PLS COMPATIBLE GUIDE ROLLER KIT (GRK) - FIELD DEMONSTRATION TEST RESULTS

FINAL REPORT

Contract Number DAAA15-90-C-0013

January 1991



ABERDEEN PROVING GROUND, MARYLAND 21005-5001

ASI 91-01

PLS COMPATIBLE GUIDE ROLLER KIT (GRK) - FIELD DEMONSTRATION TEST RESULTS

Contract Number: DAAA15-90-C-0013

January 1991

By:

D. J. Shearin, Sr.

Prepared For:

Combat Service Support Division
U.S. Army Human Engineering Laboratory
Aberdeen Proving Ground, Maryland 21005-5001

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SECURITY CLASSIFICATION OF THIS PAGE

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19. ABSTRACT (*Continue on reverse if necessary and identify by block number*)

This report presents the results of a successful demonstration of a Guide Roller Kit (GRK) carried in the tool box of a PLS vehicle and used to safely off load fully loaded PLS flat racks from an M872 type line haul semitrailer using only the PLS load handling system, obviating the need for a heavy crane to download the M872 semitrailer in forward areas where such cranes or heavy duty MHE may not be readily available. The ROC for the PLS requires flat racks to be transportable on M872 type line haul semitrailers. The GRK represents a significant expansion of the PLS capabilities by enabling it to quickly off load 16.5-ton flat racks loaded with ammunition using only the PLS on board load handling system.

Currently line-haul trailers used to transport palletized ammunition to forward areas are offloaded by Rough Terrain Forklift Trucks (RTFL). Using this procedure, the average turn-around time for each M872 34 1/2-ton semitrailer is approximately one hour. Using a Guide Roller Kit (GRK) and PLS vehicle to perform this function the turn-around time is reduced to approximately eight minutes. This represents a six fold improvement.

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10 January 1991

SUBJECT: Transmittal of Final Copies of ASI Report 91-01 "PLS Compatible Guide Roller Kit (GRK) - Field Demonstration Test Results"

TO: Director
U.S. Army Laboratory Command
Human Engineering Laboratory
ATTN: SLCHE-CS (Mr. John J. Salser)
Aberdeen Proving Ground, MD 21005-5001

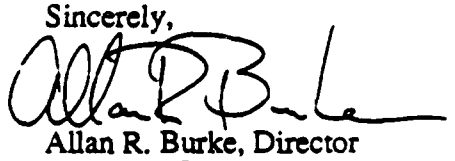
Dear Mr Salser:

Reference is made to Contract Number DAAA15-90-C-0013 dated 2 August 1990 which calls for design and fabrication of a PLS compatible Guide Roller Kit (GRK). It also requires the contractor to demonstrate the Proof of Principal (POP) of these kits by conduct of a minimum of three field trials, using Government furnished equipment required in support of the demonstration. One of the requirements of this contract is that ASI provide a draft report 30 days before contract completion for a 15 day review by the Government, and submission of a final report in hard copy and on 3.5" disk, Microsoft Word, Macintosh compatible to the COTR at contract completion."

In accordance with the above, a draft effort was provided to the Government for review and comment on 2 January 1991. Based on that review, all of the comments have been incorporated into the final report (triplicate) which is herewith enclosed. This report completes all requirements of the contract.

ASI has enjoyed the opportunity to work with the US Army Human Engineering Laboratory on this contract and looks forward to supporting HEL on future endeavors.

Sincerely,



Allan R. Burke, Director
Aberdeen Operations

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ASI 91-01

PLS COMPATIBLE GUIDE ROLLER KIT (GRK) - FIELD DEMONSTRATION TEST RESULTS

Contract Number: DAAA15-90-C-0013

January 1991

By:

D. J. Shearin, Sr.

Prepared For:

Combat Service Support Division
U.S. Army Human Engineering Laboratory
Aberdeen Proving Ground, Maryland 21005-5001

Prepared By:

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PREFACE

The work recorded in this report was authorized under Contract DAAA15-90-C-0013 dated 2 August 1990. Experimental prototype field demonstration and testing was performed on a PLS compatible Guide Roller Kit (GRK) designed and fabricated by Reynard Intermodal Engineering, Ltd. (RIWL), England, serving as a subcontractor of ASI Systems International Inc. (ASI), Orange, California. Project Management of this effort was performed by the ASI Aberdeen, MD Group. The field demonstration was performed at the U.S. Army Human Engineering Laboratory, Combat Service Support Division Logistics Technology Test Site, Aberdeen Proving Ground, MD.

ACKNOWLEDGEMENTS

The author of this report wishes to extend his thanks and appreciation to Mr. John J. Salser, the U. S. Government Principal Investigator and SSG Darrell Cumpton, U. S. Government Associate Investigator for their on-site, "hands on" technical support provided during conduct of the field demonstration. This support greatly facilitated the uninterrupted conduct of the field trials and the early dissemination of the results through the timely publication of this report.

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INTRODUCTION

The U.S. Army Human Engineering Laboratory (HEL) in cooperation with the Project Manager for Ammunition Logistics (PM AMMOLOG) have been working for the past three years on enhancements to the Palletized Loading System to expand its capabilities as an ammunition transporter.

To date, they have successfully demonstrated the Proof of Principle (POP) of an intermodal ammunition container called the AMCON, which can be picked up and transported on the PLS vehicle in the same manner as the current PLS flat rack. In addition, it offers several advantages over the current PLS flat rack in that it is intermodally compatible with all major methods of transportation, is stackable seven high in container ships, and has folding ends for easy, compact stacking for retrograde purposes. One end also folds outwardly as well as inwardly, to form a ramp for loading light vehicles for retrograde or transport.

The HEL has also successfully demonstrated, through Proof of Principle (POP) field trials, a Hooklift Interface Kit (HIK) which enables the PLS to use its on-board Load Handling System (LHS) to pick up and transport standard 20-foot commercial containers without the use of a PLS flat rack, thereby significantly increasing the flexibility and capabilities of the PLS as well as lowering road transport height.

As part of the HEL initiative to further expand the capabilities of the Palletized Loading System (PLS), HEL awarded a contract to ASI Systems International (ASI) to design and demonstrate a kit that would provide the PLS vehicle with the capability to offload fully loaded, PLS flat racks from M871/M872 type semitrailers using the PLS vehicle. This capability is possible through the use of a small, simple in design, Guide Roller Kit (GRK) carried in the tool box of a PLS. This report contains the results of a December 1990 field demonstration of the GRK.

BACKGROUND

The Commander, U.S. Army Materiel Command (AMC), while serving as Commander, Logistics Center, TRADOC, requested the HEL to determine the possibility of downloading PLS flat racks, fully loaded with ammunition, from the M871/872 line-haul semitrailers by using the Load Handling System (LHS) on the PLS vehicle.

Explanatory Note: The PLS Required Operational Capability (ROC) includes the requirement to transport fully loaded PLS flat racks on M872 type line-haul semitrailers. Of particular concern to the AMC commander was the capability to offload such flat racks

using the LHS of the PLS vehicle in those instances when a large crane would not be available to offload the flat racks.

In a limited field trial, HEL determined that it was not possible to successfully perform this task because the flat racks tended to slide to the right or left when being pulled off the semitrailer, especially when the semitrailer was on a slight side grade. If the operation had been continued, the loaded flat rack would have fallen to the ground. HEL stopped the trials due to the safety hazard presented. They did conclude, however, that the flat racks could be safely offloaded using the LHS of the PLS if a device could be designed to fit into the corner castings of the flat racks that would prevent the flat racks from sliding to either side as they were being pulled off the rear end of the semitrailer by the hook of the LHS on the PLS.

Based on a rough conceptual sketch of such a device, two guides with rollers which extended downward 4-in along each side of the bed of the semitrailer were fabricated and provided at no cost to the Government for experimentation. These brassboard items were used to successfully transfer a PLS flat rack, loaded with 16 1/2-tons of ammunition, from the bed of an M872 semitrailer to the PLS truck and then to the ground using the LHS on-board the PLS. It was not possible to transfer the second flat rack located on the forward half of the M872 semitrailer because the hook of the LHS could not reach to the mid point of the semitrailer to engage the bail bar of the flat rack. Based on this experience, a small business contract was awarded ASI Systems International (ASI) to design, fabricate and demonstrate a Guide Roller Kit (GRK) that could be used to effectively offload two fully loaded PLS flat racks from an M872 type semitrailer using the LHS on the PLS. Engineering design and metal fabrication support was provided by W&L Inc., a sub-contractor of ASI.

During discussions with HEL following award of the contract, ASI proposed to provide two kits of the primary design single roller guide, and one kit of a more complex design containing two rollers and a built-in screw jack at no additional cost. The idea behind this secondary design was that one of the rollers would interface with the side rail on the semitrailer in the same manner as the primary design while a second roller would rest between the bed of the semitrailer and the bottom of the flat rack. When the handle of the screw jack is turned in a clockwise motion, the weight would be transferred from the International Standards Organization (ISO) corner castings on the bottom of the flat rack to the roller thereby reducing the amount of drag when the flat rack was being transferred from the semitrailer to the PLS vehicle.

PURPOSE

The purpose of this report is to provide a brief description of the Guide Roller Kit (GRK) and its use in off loading PLS flat racks from M872 semitrailers with the PLS on-board LHS, and to summarize the results of ASI's successful field demonstration of the kit.

ITEM DESCRIPTION

Each GRK is comprised of six identical guide rollers, two of which are locked into the two rear corner castings of the flat rack nearest the rear end of the semitrailer and four that are locked into the four corner castings of the second flat rack located on the front of the semitrailer. (Figure 1) The purpose of the guide rollers is to prevent the flat racks from sliding off either side of the semitrailer onto the ground as the flat racks are pulled from the semitrailer onto the PLS vehicle. A photograph of the Single Guide Roller is shown at Figure 2. A drag sling (Figure 3) is used during the removal of the second flat rack. Its purpose is to pull the flat rack from the front to the rear of the semitrailer where the bail bar of the flat rack can be reached by the hook of the LHS on the PLS.

As discussed above, the contractor demonstrated two different designs of the guide roller kit, one consisting of a guide with a single side roller (Figure 2), and one consisting of a guide with a side roller, a bottom roller, and a screw jack (Figure 4). Figure 5 shows one complete Guide Roller Kit consisting of six guide rollers and a drag sling with end attachments. The guide roller assemblies and sling attachments are made of steel. The arms of the sling are nylon.

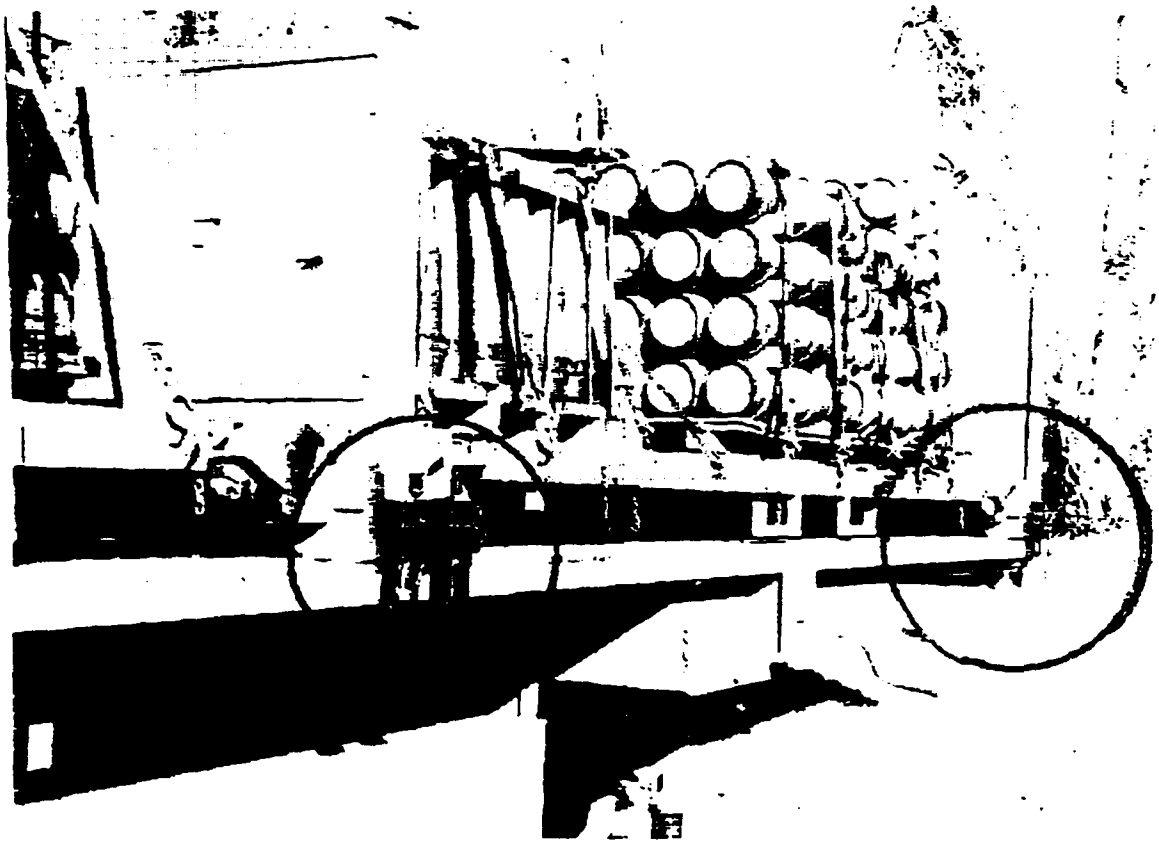


Figure 1. Guide Rollers Mounted on the PLS Flat Racks

Figure 2. Single Guide Roller (WLI 6001/00/00)

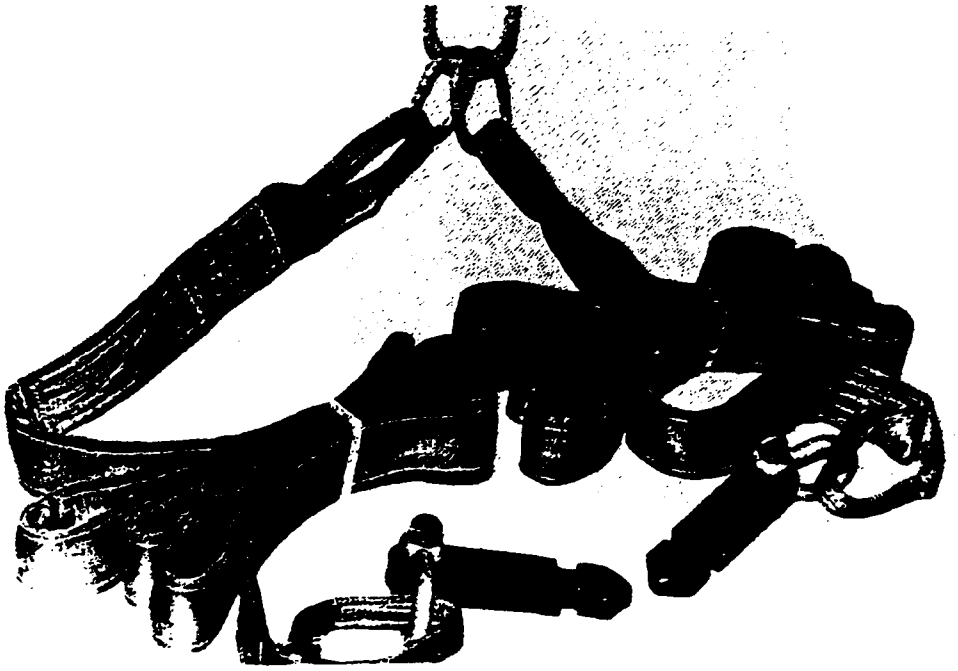


Figure 3. GRK Drag Sling Assembly (WLI 6004/00/00 with attachment WLI 6002/00/00)

Figure 4. Double Guide Roller with Screw Jack (WLI 6001/00/00)

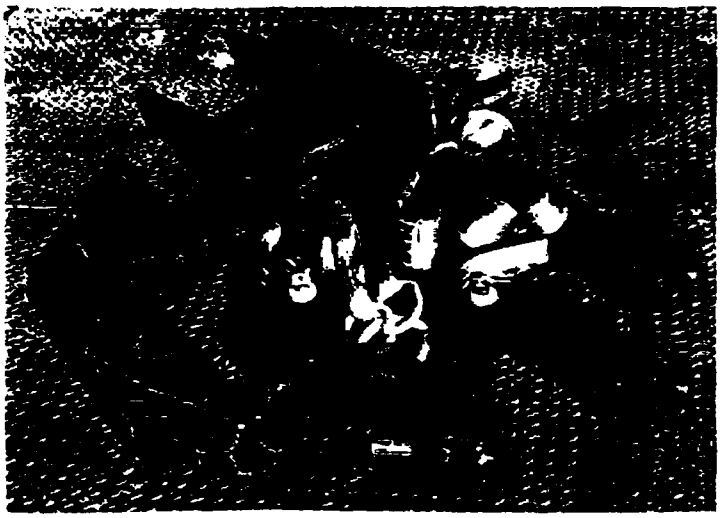


Figure 5. A Complete Guide Roller Kit

Figures 6 through 10 are photographs of the Guide Roller Assemblies and Drag Sling shown in an operational mode for the offloading of PLS flat racks loaded with ammunition from an M872 34-1/2-ton line-haul semitrailer, using the Load Handling System of the PLS.

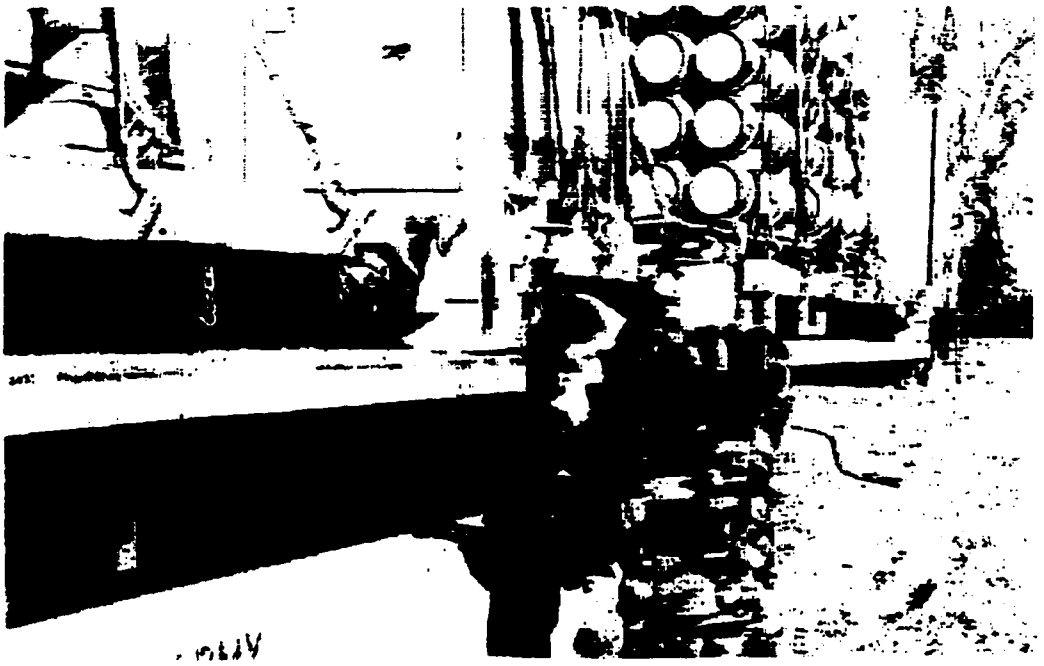


Figure 6. Installing the Guide Rollers on the PLS Flat Racks

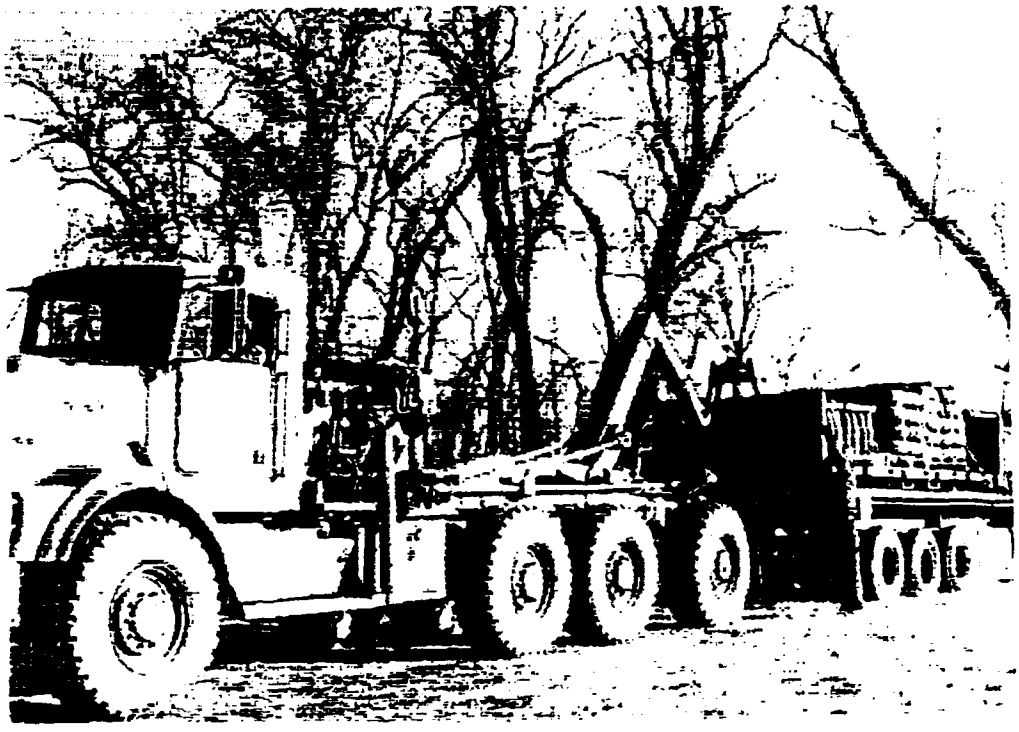


Figure 7. Transferring the First Loaded Flat Rack from the M872 Semitrailer to the PLS

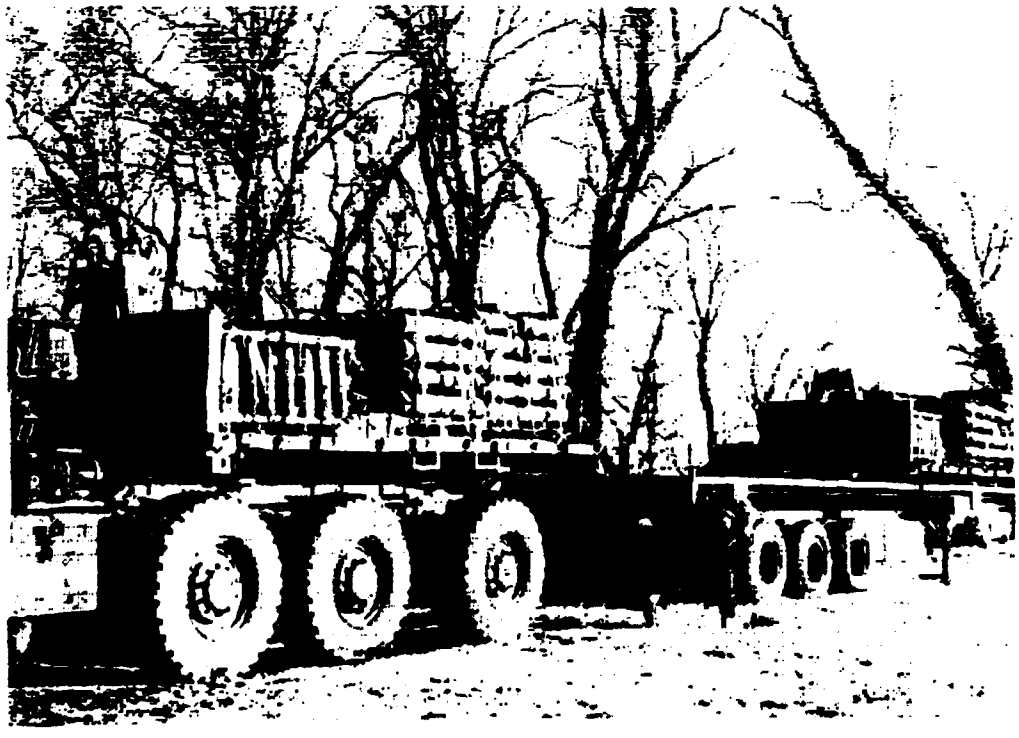


Figure 8. Transfer of First Loaded Flat Rack from M872 Semitrailer to PLS Complete

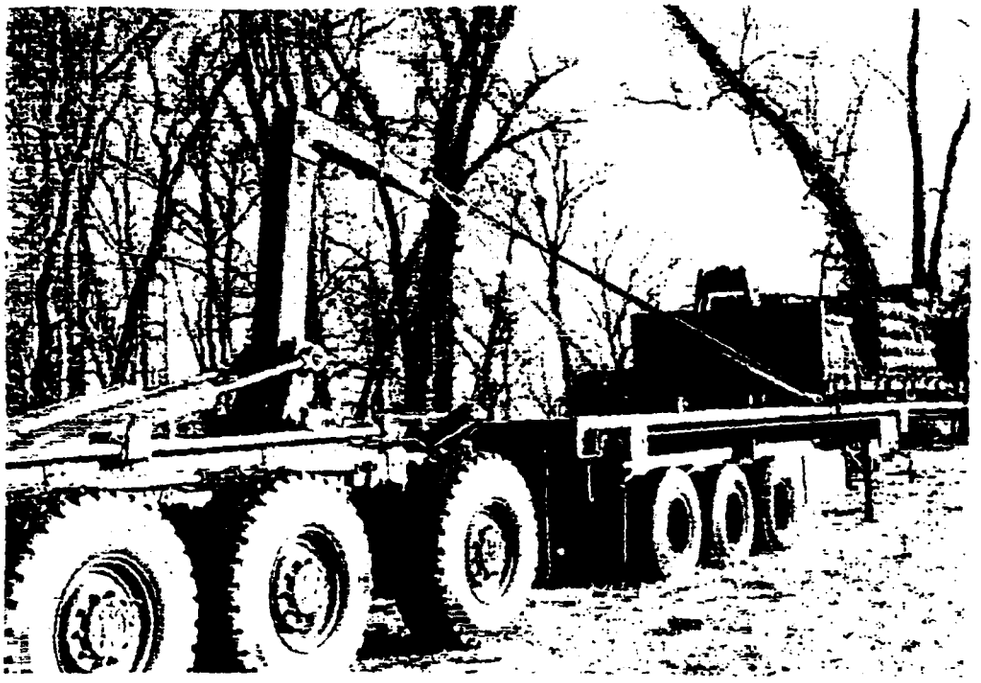


Figure 9. Using Drag Sling Assembly to Pull Second Flat Rack from Front of M872 Semitrailer to Rear where it can be engaged by the LHS of the PLS

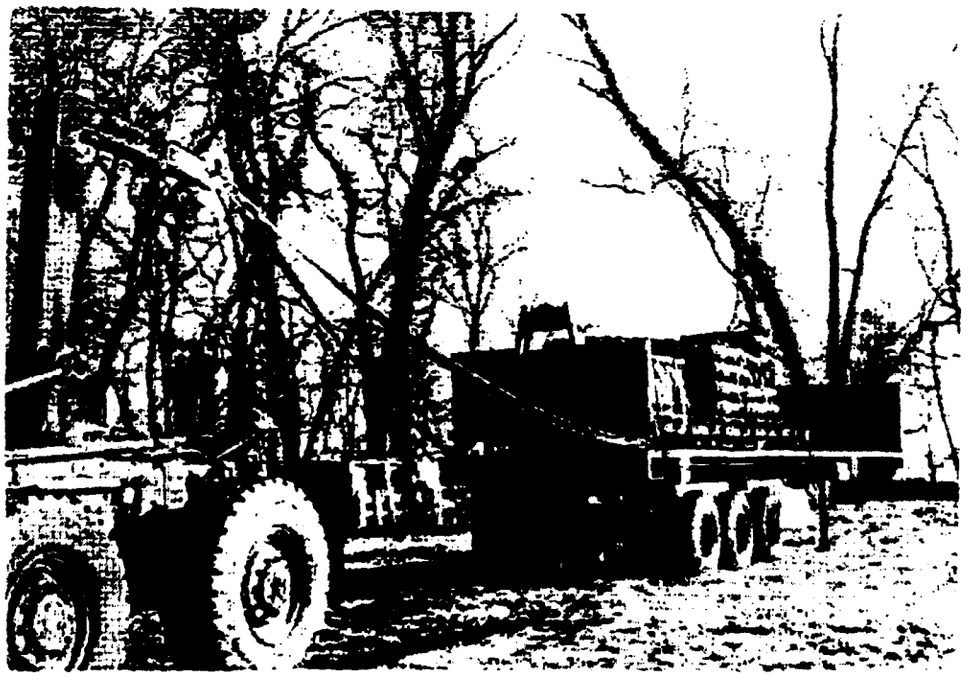


Figure 10. Second Flat Rack on Rear of M872 Semitrailer

Table 1 contains a listing of the weights and sizes of each component. A copy of Level 1 Engineering Drawings for all components of the kit are at Appendix 1 of this report.

Table 1 - GRK Component Characteristics

Single Roller Design	Weight	Width	Height	Depth
Guide Roller Assy., WLI 6001/00/00	15.50-lbs	6.5-in	9.0-in	6.5-in
Drag Sling Attachment 6002/01/00/00	45.87-lbs	4.0-in	0.19-in	*20.83-ft
Double Roller Design				
Guide Roller Assy WLI 6003/00/00	34.37-lbs			
Drag Sling Assembly 6004/00/00	28.50-lbs	4.0-in	0.19-in	*20.0-ft

**When the drag sling is rolled into a tight circle, it measures approximately 14-in in diameter.*

Based on the above, a set of six Guide Rollers (WLI 6001/00/00) and Drag Sling Assembly (WLI 6002/00/00) would weigh a total of 138.87-lbs. A set of six Guide Rollers with Screw Jack Assembly (WLI 6003/00/00) and Drag Sling with attachment would weigh 234.72-lbs. This represents an increase of 95.85-lbs or a 69% increase in weight over the kit with the WLI 6001/00/00 Guide Roller Assembly and Drag Sling WLI 6003/00/00.

MOUNTING AND DISMOUNTING OF GUIDE ROLLER ASSEMBLIES

The following procedures are provided for the fitting of the various assemblies onto a PLS flat rack and removing or dismounting the assemblies from the flat racks. The parenthetical numbers refer to the numbered parts on the drawings shown in Appendix I:

A. Fitting the Single Roller Guide Assembly:

1. Turn handnut (2) counter clockwise until bayonet (3) is in line with the stem. When in the unlocked position the retaining pin will be horizontal.

2. Enter bayonet (3) and stem into side aperture of the flat rack corner casting until the body of the guide roller contacts the outer face of the casting.

3. Turn the handnut (2) counter clockwise 90°. Correct position will be indicated by a "click" as the balls (5) enter into the positioning recesses. When the retaining pin is in the vertical position, the guide roller will be in the locked position.

4. Turn handnut (2) clockwise until no free movement of the assembly against the corner fitting can be seen and/or felt.

B. Dismounting the Guide Roller Assembly:

1. Turn handnut (2) counter clockwise until it stops.

2. Push handnut (2) fully into body of assembly.

3. Rotate handnut (2) counter clockwise 90°. Correct position will be indicated by a "click" as balls (5) enter into positioning recesses. The retaining pin will be in the horizontal position.

4. Remove assembly from corner casting of PLS flat rack

NOTE: Support the weight of guide roller during dismounting to prevent it from falling to the ground causing possible injury to operator.

C. Operation of Drag Sling WLI 6001/00/00 and Drag Sling Attachment WLI 6002/01/00.

1. Lay out drag sling (WLI 6004/00/00) on the rear section of the semitrailer deck after first PLS flat rack has been removed.

2. Position center attachment ring rearmost in the center of the semitrailer and the nylon straps laid flat without twists towards the corner fittings of the PLS flat rack to be removed.

3. Insert drag sling attachment (WLI 6002/01/00) into front aperture of corner fitting of flat rack, pointed end first.

4. Rotate 90° to engage slot into face of corner casting.

5. Place the "O" ring of the drag sling onto the hook of the LHS of the PLS. The unit is now ready for operation.

6. Disconnect sling by rotating drag sling attachment 90° and withdraw from corner casting. Coil drag sling and stow neatly.

D. Fitting the Double Roller Guide with Jacking Assembly WLI 6003/00/00

1. Insure that carrier (12) is in the fully retracted position inside the body. If the roller is extended, retract by turning handle (12) counter clockwise until full retraction is achieved.

2. Turn the handnut (2) counter clockwise until bayonet (3) is in line with the stem. When in the unlocked position, the retaining pin will be in the horizontal position.

3. Enter bayonet (3) and stem into side aperture of the flat rack corner casting until the body of the guide roller contacts the outer face of the casting.

4. Turn the handnut (2) counter clockwise 90°. (Correct position will be indicated by a "click" as balls (5) enter into the positioning recess.) When the retaining pin is in the vertical position the guide roller will be in the locked position.

5. Turn handnut (2) clockwise until no free movement of the assembly against the corner fitting can be seen.

6. Turn handle (12) clockwise until corner fitting is raised above the level of the semitrailer deck.

NOTE: On sloping ground where flat racks might start to roll out of control, it is suggested that the two rearmost assemblies are fully extended while the two forward assemblies are partially extended reducing the load on the corner fittings, but maintaining contact with the semitrailer deck to act as a brake.

E. Dismounting of Guide Roller Assembly 6003/00/00

For dismounting, reverse the above installation instructions.

OPERATION OF GUIDE ROLLER ASSEMBLY

To transfer the first flat rack located on the rear half of the semitrailer from the semitrailer to the PLS vehicle, the driver and/or assistant places two guide rollers into the two rear corner castings of the PLS flat rack. The driver then backs up the PLS to within 12- to 18-in from the rear of the semitrailer containing the two loaded flat racks. He then maneuvers the hook of the LHS onto the bail bar on the front of the flat rack by using the LHS control lever in the cab of the vehicle. He continues to operate the LHS controls to begin the transfer the flat rack from the bed of the semitrailer onto the PLS vehicle. Once the rear end of the flat rack clears the bed of the semitrailer, the transfer is momentarily stopped while the assistant removes the two guide rollers from the flat rack and places them on the ground. The uploading cycle is then continued until the flat rack is completely on the PLS.

In transferring the second flat rack from the semitrailer to the PLS, a guide roller must be connected to each of the four corners of the flat rack. A drag sling, shown in Figure 3, is used to pull the second PLS flat rack from the front of the semitrailer to the rear. The sling consists of two nylon straps attached to a metal "O" ring which is placed

over the hook of the LHS on the PLS. The metal attachments on the ends of each arm of the sling are inserted and secured into the front two corner castings of the PLS flat rack as indicated in Paragraph "C" above. One each guide roller is securely locked into each of the four corners of the PLS flat rack.

Once the sling and guide rollers are in place, the driver raises the hook on the LHS until the arms of the sling are on an angle of 30- to 45° with the bed of the semitrailer. The PLS vehicle is then slowly driven forward pulling the flat rack to within approximately 12- to 18-in of the rear end of the semitrailer. The vehicle is halted and backed up a few inches to reduce the tension on the swing. The sling and forward two guide rollers are removed from the front corner castings of the flat rack. The driver backs up the vehicle to within 12- to 18-in from the rear of the semitrailer, engages the hook of the LHS on the bail bar of the flat rack and then operates the LHS to begin transferring the flat rack from the semitrailer to the PLS. Once the flat rack clears the semitrailer, the remaining two guide rollers are removed from the rear corner castings of the flat rack and the uploading is continued until it is secured on the PLS.

No special tools are required to connect or disconnect the GRK from the corner castings of the flat rack. Due to the compactness of the kit, it can be stored in the tool box on the PLS.

DESIGN OF THE FIELD DEMONSTRATION

Each trial was divided into three sub-functions and each sub-function was timed separately as follows:

1. Sub-function #1 - Install Six GRK Roller Sub-assemblies: The driver was required to install one sub-assembly in each of the two corner castings on the left side of the flat rack located nearest the front of the semitrailer and one each in the corner casting on the left rear of the flat rack located nearest the rear end of the semitrailer. The assistant simultaneously installed and secured one roller sub-assembly in the right side corner castings of the flat racks opposite those installed by the driver. "Time start" was on signal from the time keeper to proceed. "Time stop" was recorded when the last roller sub-assembly had been installed and secured in place.

2. Subfunction #2 - Transload one Flat Rack from an M872 Semitrailer onto a PLS and then from the PLS truck to the Ground: Once the guide rollers were in place, the driver re-entered the vehicle cab and lowered the hook of the LHS until it was

slightly below the bail bar on the PLS flat rack nearest the rear of the semitrailer. On signal from the time keeper, and guided by hand signals from the assistant, the driver engaged the bail bar on the flat rack with the hook on the LHS and began uploading the flat rack onto the PLS. When the rear of the flat rack cleared the floor of the semitrailer, the uploading was stopped while the assistant disconnected the two Guide Roller subassemblies. He then signaled the driver to continue loading the flat rack onto the PLS. When loaded, the driver pulled his vehicle forward approximately 100-feet to the right of the road, downloaded the flat rack onto the ground, and returned to his original position with the back of the PLS approximately 12- to 18-in from the rear of the semitrailer. While the driver was downloading the first flat rack, the assistant was connecting the drag sling to the second flat rack on the semitrailer in preparation for pulling it to the rear of the semitrailer where the bail bar could be engaged by the hook of the LHS. "Time start" was given on signal from the time keeper to the driver to start the trial. "Time stop" was recorded when the driver had downloaded the flat rack onto the ground and the vehicle was back at its original position with the back of the PLS near the back of the semitrailer.

3. Subfunction #3 - Transload the Second Flat Rack from an M872 Semitrailer onto a PLS: When the PLS returned to the rear of the semitrailer, the assistant placed the "O" ring of the Drag Sling onto the hook of the PLS LHS and signalled the driver to elevate the hook of the load handling system (see page 12) and then move the vehicle forward until the front end of the second flat rack was within 12-to 18-in from the rear of the semitrailer. At this point the driver stopped the vehicle and backed it rearward a few inches to release the tension on the drag sling. The assistant then disconnected the drag sling assembly from the flat rack and the vehicle LHS. He then signaled the driver to back up the vehicle and engage the bail bar with the hook of the LHS and begin uploading the flat rack. When the front of the flat rack had been raised a few inches above the bed of the semitrailer, the driver momentarily stopped the uploading while the assistant removed the guide roller from the front left and front right ISO pockets of the flat rack. The uploading was then continued until the rear of the flat rack had cleared the bed of the semitrailer. Again the uploading was momentarily stopped as the assistant removed the remaining two guide rollers. The driver then completed the uploading of the second flat rack onto the PLS. "Time start" was by signal from the time keeper. "Time stop" was recorded when the second flat rack cleared the semitrailer.

RESULTS OF THE FIELD DEMONSTRATION

The Guide Roller Kit performed exceptionally well, fully meeting the required demonstration objectives. Table 2 shows the times required for attaching the six rollers to the two flat racks for each trial (Sub-function 1); the times required to transload the first flat rack from the semitrailer onto a PLS and thence to the ground, (Sub-function 2); and the time required to transload the second flat rack from the semitrailer onto the PLS. The last column contains the total time required for each trial.

Table 2 - Times Required to Offload Two Fully Loaded PLS Flat Racks from the Bed of an M-872 Semitrailer Using the LHS on the PLS and a GRK.
(Times shown are in minutes)

Trial #	Subfunction #1	+	Subfunction #2	+	Subfunction #3	=	Total Time
1	0.60		3.62		3.87	=	8.09
2	0.45		4.33		3.37	=	8.15
*3	7.22		4.87		3.48	=	15.57

** NOTE: Trial #3 was performed using the kit with two guide rollers with built in screw type jack WLI 6001/00/00.*

ANALYSIS OF DEMONSTRATION RESULTS

A. GRK Using Single Roller Primary Design Guide Roller Assembly

The primary design GRK, with the single roller assembly functioned flawlessly during the demonstration. All soldier and/or equipment interfaces including weight of each component and ease of operation, based on only five minutes training, were very satisfactory. As can be seen from Table 2, during the demonstration with only one practice "dry run," all six assemblies were attached in approximately 1/2-minute for demonstration trials 1 and 2. Total time to attach the guide rollers and offload two fully loaded flat racks from the PLS was slightly over 8-minutes. During earlier field trials conducted by HEL in which they were offloading palletized ammunition from PLS flat racks one pallet at a time using a rough terrain fork lift, the average time was approximately 30 minutes, or 1-hour to offload two flat racks. Therefore in a typical operational scenario, the turnaround time for unloading a line-haul, M872 type semitrailer, at a forward Ammunition Supply Point (ASP) or Ammunition Transfer Point (ATP) and its release for a return trip back to the

depot for another load, using the fork lift mode of offloading, would be approximately 1- hour. This compares with an average of only 8.12-minutes for unloading two fully loaded PLS from the semitrailer to the ground using the primary design Guide Roller Kit which is an 86.5% savings in offloading time. If a line-haul tractor and M872 semitrailer were required to make four round trips in a 24 hour period which is considered to be representative of a typical ammunition resupply operation, a savings of 3.46-hours could be realized out of each 24 hour period for each line haul vehicle (60.00 - 8.12 = 51.88 minutes x 4 trips = 207.52-minutes divided by 60 minutes = 3.46-hours). Extending these computations to a typical line haul transportation truck company, a savings of several vehicles in the TO&E, or a comparable increase in tonnages hauled with the same number of vehicles would be possible.

If a unit's ammunition vehicles were to meet a line-haul semitrailer at a pre-arranged transfer point, the flat racks would not have to be grounded. Rather, they could be transferred directly from the semitrailer to the unit's PLS vehicles without the requirement for materiel handling equipment.

B. GRK Using the Alternative Design Double Roller with Jack Guide Roller Assembly

When taking measurements of the M872 semitrailer in preparation for the design of the Guide Roller Assembly with screw jack and two rollers, the Army provided a semitrailer with a 3/8-in thick guide rail welded to the outside edge of each side of the semitrailer. When the Army provided a semitrailer for the demonstration, it was noted that it had apparently been procured from a different manufacturer as the guide rails were missing from both sides of the semitrailer. Therefore, during the demonstration of the alternative design GRK with two rollers, approximately two-thirds of the 3-in wide bottom roller extended beyond the outer edge of the semitrailer due to the lack of side guide rails. Therefore, the bottom rollers assumed a 45° angle rather than resting on the top flat surface of the semitrailer which resulted in the bottom roller to momentarily "hang up" in each of the side pockets used for mounting stake type sides on the semitrailer. Figure 11 shows the indentation below the surface of the semitrailer bed at the point of each side pocket. This, in turn, resulted in delays in the offloading process.

A significant delay was also experienced in installing the guide with double rollers and screw jack onto the corner pockets of the flat rack. While the guide with the single roller interfaced with only one side of the corner pocket, the guide with the double rollers had to interface with two side faces of the corner pocket. Because the welds attaching the corner pocket onto the flat rack projected beyond the side of the casting, the driver and

B. Responsibilities:

The ASI Project Officer will be responsible for providing the prototype hardware, will prepare the Test Protocol and Field Test Plan for Conduct of a contractor field demonstration and follow-on Limited Proof of Principal type field trials by HEL. He will provide on site technical support during the conduct of the limited field trials. The Government principal investigator will be responsible for supporting the ASI Project Officer including the provision of GFE equipment and equipment operating personnel for conduct of the concept demonstration. He will also provide Test Personnel (TP) required for conduct of the limited, timed field trials. The Government principal investigator will also serve as on-site Safety Director with responsibility for insuring that the contractor demonstration and follow-on Government field trials are conducted in accordance with applicable safety directives of the Aberdeen Proving Ground and the Human Engineering Laboratory.

C. Test Location:

The tests will be conducted at the HELFAST Logistics Test Site, Edgewood Area, Aberdeen Proving Ground, MD or a comparable site in the Aberdeen Proving Ground area as may be designated by the COTR.

D. Physical and Psychological Qualifications:

No special physical or psychological qualifications are required for this test other than those specified for performance of the TPs current job descriptions.

E. Apparatus:

Equipment to be Used in the Test: The following equipment is required to be used in support of the demonstration and follow-on Government field trials.

- Prototype Guide Roller Kit (GRK)(3 sets)
- PLS vehicle
- 34-1/2 ton, M872 Semi-trailer,- (use of 5-ton Tractor Trailer desired)
- 4000 pound capacity RTFL
- Palletized inert and "dummy" ammunition
- Stop watches and/or electronic data collection devices

All equipment will be GFE with the exception of the GRK .

Figure 2 is a drawing of the PLS Guide Roller Assembly and Figure 3 is a schematic showing the operation of the Drag Sling.

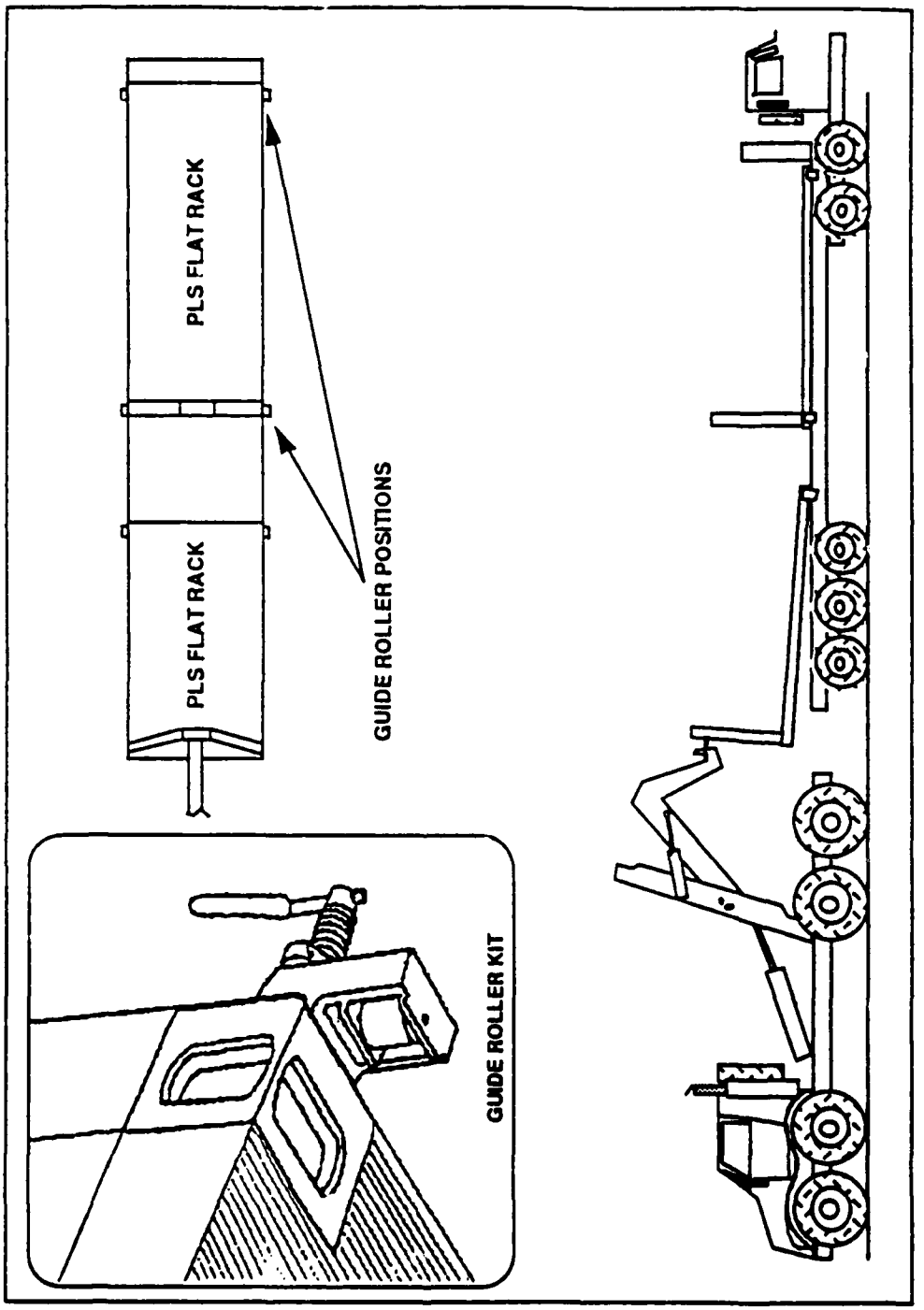


Figure 2. PLS Guide Roller Assembly

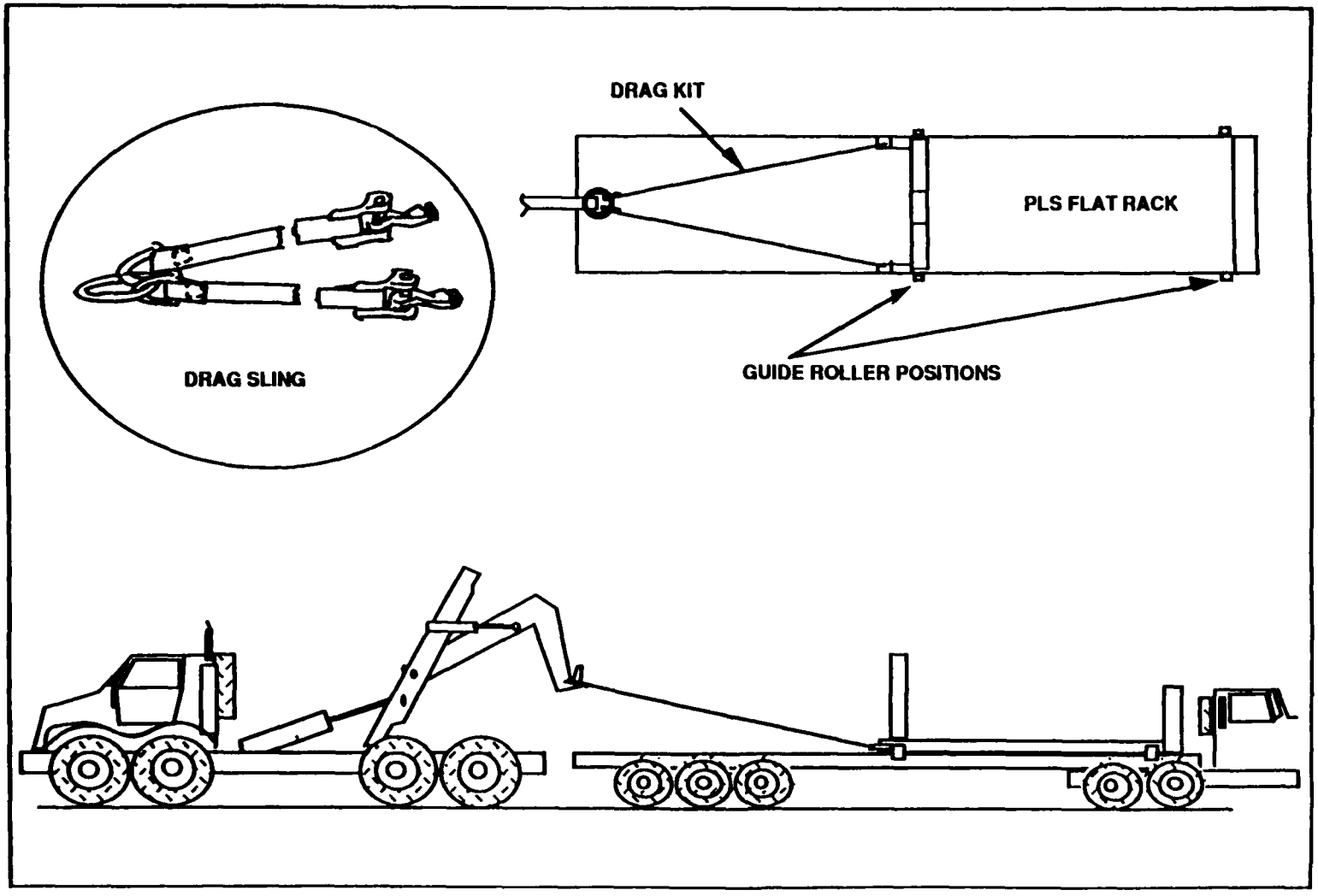


Figure 3. Drag Sling Operation

F. Field Layout of Equipment

If the HELFAST Logistics Research Test Site is selected for the demonstration and field testing all trials will be performed in the area located to the right of trailer at the HELFAST Test Site (See Figure 4). Prior to start of the demonstration, an M872 trailer with two flat racks each loaded on the bed of the trailer and parked on the dirt road. Each flat rack will contain an artillery unit Combat Configured Load (CCL) consisting of 15 pallets of 155mm projectiles, 2 pallets of Red Prop Charges, 1 Pallet of Green Prop Charges and 2 pallets of White Prop Charges. Three GRK roller subassemblies will be placed on the ground on each side of the trailer. The Drag Sling will be placed on the ground to the right side of the trailer. The PLS vehicle without a flat rack will be backed to within approximately 12 to 18 inches of the rear end of the M872 trailer. *Note: One of the demonstration trials will be conducted with the trailer parked on a 3- to 5° slope to determine if there is any impact on the functioning of the GRK.*

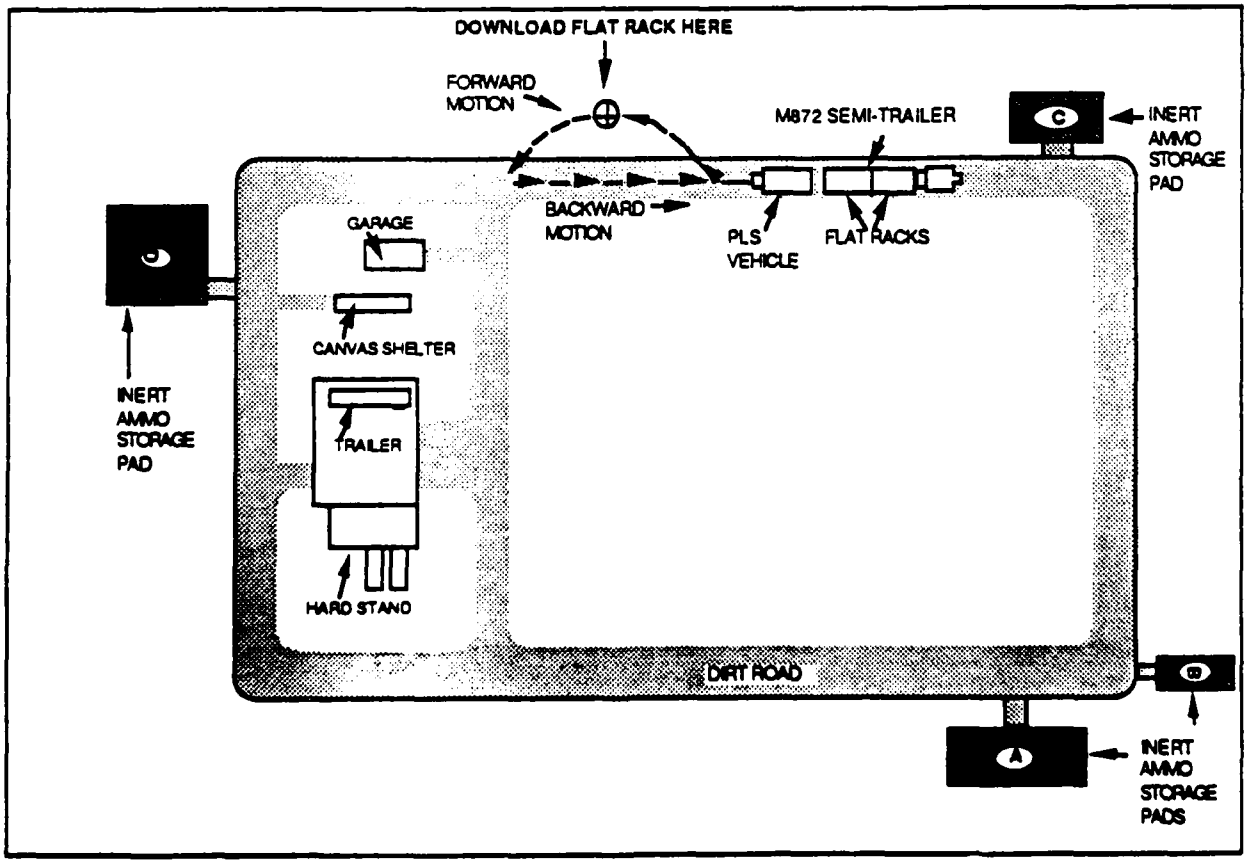


Figure 4. Schematic of Test Layout (HELFAST Test Site).

G. Contractor Equipment Demonstration:

Once the experimental equipment has been delivered to the HELFAST test site, and prior to the beginning of the Government timed Proof of Principle trials, ASI will demonstrate the operation and functions of the GRK. This demonstration will consist of trials #1, #2, and #3 in which flat racks #1 and #2 will be transferred from the M872 trailer to the PLS vehicle and then onto the ground by use of the GRK in conjunction with the on-board PLS LHS.

H. HEL Pre-Timed Trials:

Because of the experimental nature of the equipment (soft tooling of brassboard prototype models), it is expected that some adjustments as well as minor modifications of the equipment may be required prior to beginning of Government trials. Once the development contractor and/or his supporting subcontractor(s) have taken these corrective actions, the HEL and PM AMMOLOG personnel will conduct a limited number of pre-timed trials in order to:

- Determine the design feasibility of the GRK
- Make any further design changes considered necessary to improve the operability and operational effectiveness of the GRK
- Provide a learning process for the test participants prior to conduct of the timed trials, and
- Validate the test plan.

Following completion of these pre-timed trials, timed test trials will be conducted.

I. GRK Timed Test Trials:

1. Objective: The objective of these GRK timed trials is for the Government to determine the feasibility of transferring PLS flat racks loaded with ammunition, from the bed of an M872 34 1/2 ton trailer onto the PLS by use of the on-board PLS Load Handling system.

2. Procedure: Each trial is divided into three subfunctions as follows.

a. Subfunction #1 - Install Six GRK Roller Subassemblies: The driver will install one subassembly in each of the two corner castings on the left side of the flat rack located nearest

the front of the trailer and one each in the corner casting on the left rear of the flat rack located nearest the rear end of the trailer. The assistant driver will simultaneously install and secure roller subassemblies in the right side corner castings of the flat rack, opposite those installed by the driver. "Time Start" will be on signal from the time keeper. "Time Stop" will be recorded when the last roller subassembly has been installed and secured in place

b. Subfunction #2 - Transload one Flat rack from an M872 Trailer onto a PLS and Place it on the Ground: The driver will lower the hook of the LHS until it is slightly below the bail bar on the PLS flat rack nearest the rear of the trailer. On signal from the time keeper and guided by hand signals from the assistant driver on the ground, the driver will engage the flat rack with the hook on the LHS and begin uploading the flat rack onto the PLS. When the rear of the flat rack is clear of the floor of the trailer, the assistant driver will signal the driver to stop. The assistant driver will disconnect the two Guide Roller subassemblies and then signal the driver to continue loading the flat rack. When loaded, the driver will pull forward approximately 50 ft to the right of the road, download the flat rack and return to his original position with the back of the PLS approximately 12 to 18 inches from the rear of the trailer. "Time Start" will be on signal from the time keeper. "Time Stop" will be recorded when the PLS has downloaded the flat rack is back at original position with the back of the PLS near the back of the trailer.

c. Subfunction #3 - Transload the second Flat Rack from an M872 Trailer onto a PLS: While the driver is downloading the first flat rack from the PLS to the ground, the assistant driver will connect the two ends of the Drag Sling subassembly into the bottom two corner castings on the front of the second flat rack. When the PLS returns to the rear of the trailer, the driver will place the "O" ring of the Drag Sling subassembly onto the hook of the PLS LHS and signal the driver to move the vehicle forward until the front end of the flat rack is within 6 to 12 inches from the end of the rear of the trailer. At this point, the driver will stop and release tension on the Drag Sling subassembly by backing the vehicle rearward a few inches. The assistant driver will then disconnect the Drag Sling assembly and the front two Guide Rollers, and signal the driver to back the PLS towards the rear of the trailer and start the transfer. When the flat rack is clear of the floor of the trailer, he will signal the driver to stop the transfer. The assistant driver will then disconnect the last two guide rollers and signal the driver to continue the transfer of the second flat rack onto the PLS. "Time Start" will be on signal from the assistant driver. "Time Stop" will be recorded when the second flat rack has been transferred from the trailer onto the PLS.

The early part of the first day of the pretimed trials will be devoted to the developmental contractor's demonstration of the GRK equipment and pre-timed trials with the TPs becoming

familiar with the operations and functions of the GRK including the locking of the Guide Roller subassemblies onto the PLS flat rack, the connecting of the Drag Sling subassembly onto the second PLS flat rack, and the dragging forward of the second flat rack and removal of the Guide Rollers from the PLS flat rack corner castings.

ASI will be responsible for conduct of the first three timed trials and will include the results of these trials in a final report. HEL will be responsible for the remainder of the timed trials.

Tables 1 and 2 are summary matrices of the experimental design showing the order of presentation for Day 1. Each TP will serve alternately as a driver and as an assistant driver. *Trials 1, 2, 4 through7, and 15 through 21 will be performed using the single roller subassemblies of the GRK. Trials 3, 8 through 14 and 22 through 30 will be performed using the double roller subassemblies of the GRK.*

Table 1

Experimental Design Matrix Showing Order of Presentation Day 1, Time Trials: Attach the Guide Roller and Drag Sling Assembly to the PLS Flat Rack and Transload the Flat Racks from the M872 Trailer to the PLS Vehicle and Thence onto the Ground

Time	Trial #	Driver #	Asst. #	Time	Trial #	Driver #	Asst. #
0800	1	1	2	1130	8	3	2
0830	2	2	3	1300	9	4	3
0900	3	3	4	1330	10	5	4
0930	4	4	5	1400	11	6	5
1000	5	5	6	1430	12	1	6
1030	6	6	1	1500	13	3	5
1100	7	2	1	1530	14	4	6

6 test subjects each serving in 2 positions = 30 permutations

3. Description of Constraints on the Experimental Design

There are no apparent constraints on the experimental design other than reasonableness of the numbers of available test participants. Because of the limited number of available HEL personnel to participate in the trials, the number of trials is somewhat limited by the number of permutations of six personnel each serving in two positions equals 30 permutations. This number of trials is considered to be adequate to perform the "Proof of Principle" of an experimental prototype item of equipment.

Table 2

Experimental Design Matrix Showing Order of Presentation

(Day Two), Timed Trials (same procedure as Day #1)

Time	Trial #	Driver #	Asst.#	Time	Trial #	Driver #	Asst.#
0800	15	5	1	1300	23	2	5
0830	16	6	2	1330	24	3	6
0900	17	1	3	1400	25	5	3
0930	18	2	4	1430	26	6	4
1000	19	4	1	1500	27	1	5
0130	21	5	2	1530	28	2	6
0100	21	6	3	1600	29	3	1
1130	22	1	4	1630	30	4	2

6 test subjects each serving in 2 positions = 30 permutations

J. Data Collection and Support:

ASI will be responsible for data collection. Data for the timed trials will be recorded on the form shown at Appendix A.

K. Debriefings:

Daily informal debriefings on the specifics of the day's testing will be performed by the Principal Investigator or his assistant at the end of each test day. Adjustments as may be required to the following day's test schedule will be announced at the conclusion of the debriefing.

assistant had a difficult time installing the guide with the double rollers. The average time to attach the guide with the single roller (Subfunction 1) was 0.52-minutes, as compared with 7.22-minutes required for attaching the guide with double rollers.

Figure 11. Well for Mounting Sides to Semitrailer

FINDINGS

1. General

a. The objective of the demonstration was successfully met. The guide roller kit can be used for the successful offloading of PLS flat racks loaded with ammunition from an M872 type flat bed semitrailer using the LHS of the PLS, thus obviating the need to provide a separate heavy duty crane or other type of MHE at the off loading site to perform this function.

b. In comparison with the current procedure for offloading ammunition from M872 type line-haul semitrailers one pallet at a time using a rough terrain fork lift, the GRK offers more than a six fold improvement in offloading time.

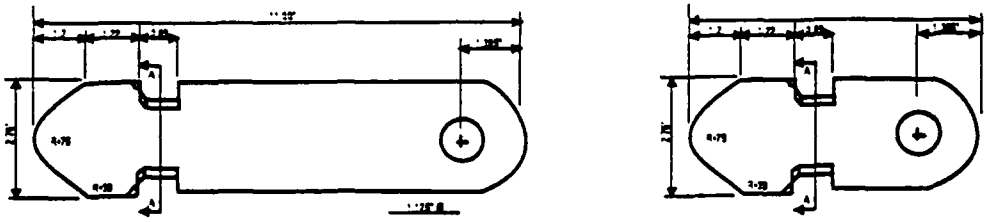
2. Specific

a. The primary design GRK with the single roller performed flawlessly and requires no change.

b. Due to the increased complexity of the alternative design, increased cost, increased time to install the assemblies, increased weight of the double roller assembly with screw jack, and the difficulties experienced in turning the handle of the screw jack to

transfer the weight of the container from the deck of the semitrailer to the rollers (does not meet the design range from the 5th to 95th percentile values), further development is not warranted. The flat rack appeared to slide with relative ease on the metal strips on the deck on the semitrailer when the primary design roller assembly with only the single side roller was used.

c. As with any experimental prototype item, the tendency with the GRK was to build in a greater margin of safety because of unknowns. The drag sling, for example was designed with a capability to actually lift a fully loaded flat rack of ammunition. It is suggested that significant savings in weight can be achieved by a simple redesign of the Drag Sling to reduce the weight by up to 75% and still satisfactorily perform its intended function. Also, by a simple design change as shown in Figure 12, the weight of the end connectors used with the drag sling can be reduced by an estimated 30%.



End Effector: Current Design

End Effector: Redesign

Figure 12. Redesign of End Effector of Drag Sling

d. Applying a small amount of grease or other lubricant to the metal surfaces on the semitrailer that come in contact with the rails on the flat rack would reduce the coefficient of friction by 50% which would permit still a further reduction in the weight of all components if this procedure is acceptable to the Army.

e. During the conduct of the demonstration, it was apparent that only four guide rollers rather than six are required for the offloading of PLS flat racks from the semitrailers as the two used to offload the first flat rack can be re-used for offloading of the second flat rack located on the front of the semitrailer. This would result in a savings of 31-lbs in the current GRK primary design using the single roller guide assembly and 68.4-lbs with the double roller design which represents an overall weight savings of 22% and 29% respectively.

f. The Government furnished PLS vehicle used for the demonstration was a PACCAR vehicle equipped with the Bennes Marrel Load Handling System (LHS) rather than the Multilift Mk 5 LHS, which is used on the Oshkosh PLS presently being procured

for the military. The locus of motion of the two systems is different. Although our best engineering judgment is that the Guide Roller Kit will work equally well with either system it is suggested that the Government may desire to test the performance of the GRK with a PLS vehicle equipped with the Multilift LHS.

g. Although a complete set of Proof of Principle (POP) trials was not conducted due to the limited scope of the contract, the trials conducted for the demonstration were considered adequate to prove the inability of the concept design.

RECOMMENDATIONS

1. Although the COTR approved Test Protocol and Field Test plan called for the conduct of 24 trials to effectively conduct Proof of Principal field trials, due to lack of funding, this could not be accomplished. The contract calling for the design, fabrication and demonstration called for only 3 demonstration field trials. It is therefore recommended that the remaining 21 field trials be performed in order to obtain statistically valid results in terms of times to perform the offloading function and to determine whether or not any design changes may be warranted.

2. Since this item was in response to a personal request of the Commander, AMC, recommend a copy of this report be forwarded the Commander, AMC together with the proposed schedule of a field demonstration of the GRK to the AMC commander and selected members of his staff. Also, recommend the Army schedule additional demonstrations of the GRK with selected representatives of the user and developmental communities, in order to familiarize them with this significant enhancement of the PLS capabilities.

3. Recommend immediate action be taken to proceed with the standardization, procurement and early fielding of the GRK with the single guide roller on the basis of issue of one kit per PLS vehicle plus sufficient kits in the supply system. Each kit would consist of four guide rollers and one sling assembly.

PRODUCTION COST ESTIMATE

During a technical review, the Government COTR asked that the final report provide a production cost estimate of the Guide Roller Kit in quantities of

1000, 2000 and 5,000. The following estimate is provided based on the primary design of the Guide Roller Kit, Level I drawings, a set of which is appended to this report. Unit production cost of 1,000 kits is estimated at approximately $1000.00 per kit. Quantities over 2,000 kits would yield approximately a 5% cost reduction and quantities over 5,000 would result in a 10% reduction.

This estimate is based on the assumption that each guide roller kit will consist of 4 each Guide Roller Assembly, WLI 6001/00/00, and one each Drag Sling Assembly 6004/00/00 with two each Drag Sling Attachments WLI 6002/00/00. All metal parts of the kits will be painted with the US Army OD color; and the sling straps will be fabricated from a OD colored nylon material. Costs are in FY1991 dollars.

End of Report

APPENDIX I

LEVEL I ENGINEERING DRAWINGS OF THE GUIDE ROLLER KIT (GRK)

LEVEL I ENGINEERING DRAWINGS
OF THE GUIDE ROLLER KIT
LOCATED IN ORIGINAL UNBOUND
REPORT TO HEL ONLY.

APPENDIX II

PROTOCOL AND TEST PLAN FOR CONCEPT DEMONSTRATION AND LIMITED FIELD TRAILS OF A PLS COMPATIBLE GUIDE ROLLER KIT (GRK)

TABLE OF CONTENTS

PART I - PROTOCOL FOR CONCEPT DEMONSTRATION AND LIMITED FIELD TRIALS OF A PLS COMPATIBLE GUIDE ROLLER KIT (GRK)

PART II - FIELD TEST PLAN FOR CONCEPT DEMONSTRATION AND LIMITED FIELD TRIALS OF A PLS COMPATIBLE GUIDE ROLLER KIT (GRK)

FIGURES

TABLES

APPENDIX A:

PART I - PROTOCOL FOR CONCEPT DEMONSTRATION AND LIMITED FIELD TRIALS OF A PLS COMPATIBLE GUIDE ROLLER KIT (GRK)

I. INTRODUCTION

A. Descriptive Information:

1. Project Title: Protocol for Concept Demonstration and Limited, Field trials of a PLS Compatible Guide Roller Kit (GRK).

2. ASI Technical Representative: D.J. Shearin, Project Officer (Responsible for contractor demonstration).

3. Government Principal Investigator: (Responsible for conduct of limited, timed field trials and for technical support of Contractor Demonstration).

4. Government Associate Investigator: SSG Darrell Cumpton.

5. Division: Combat Service Support Division, US Army Human Engineering Laboratory.

6. Date of Demonstration and Field Trials: Demonstration is scheduled to start on or about 15 November 1990. Limited field trials are planned to be conducted by the Government following the contractor demonstration trials.

B. Background:

1. Problem that Lead to This Research.

a. In June 1990, the US Army completed field testing of three competing models of the Palletized Loading (PLS). A limited production contract is pending award to the winner, OSHKOSH. Since the PLS offers significant advantages over a more conventional military truck because of its capability to upload and download palletized ammunition and other types of cargo secured to its flat rack type cargo bed, it behooves the Armed Forces to examine

opportunities and perform further study and experimentation with ancillary PLS compatible devices that will further enhance the performance capabilities of this versatile vehicle.

b. As part of the PLS enhancement program, the US Army Project Manager, Ammunition Logistics (PM AMMOLOG), and the US Army Human Engineering Laboratory have successfully completed Proof of Principal (POP) field trials of two PLS sub-systems that will enhance the capabilities of the PLS as follows:

(1) An Intermodal Ammunition Container (AMCON) which is compatible with the PLS and all intermodal handling and transport facilities and equipment.

(2) A Hooklift Interface Kit (HIK) that will enable the PLS, using the on-board Load Handling System (LHS), to pick up and transport a variety of ANSI ISO 20 ft containers ranging in height from 6 ft to 8.5 ft.

c. In response to a Broad Agency Announcement (BAA) issued by HEL in June 1989, ASI submitted a proposal for a number of concepts for further enhancements to the PLS, the first of which to be funded is entitled "Guide Roller Kit" (GRK). The GRK responds to a problem identified by the Commander, Logistics Center, U.S. Army Training and Doctrine Command who articulated the need for a PLS to have the capability to offload two PLS flat racks loaded with ammunition from M872 type line haul trailers, in the forward areas of the battlefield using the Load Handling System (LHS) of the PLS. When HEL attempted to offload the PLS flat racks from the trailer using the LHS, the flat racks tended to slip to either the right or left side of the trailer as it was being dragged towards the PLS. The trials were therefore terminated. Also, there was no means available to move the second flat rack from the front end of the trailer to the rear where it could be picked up with the LHS on the PLS.

The purpose of the GRK is to hold a flat rack on the bed of the M872 trailer as it is dragged towards the PLS by the LHS. Without the GRK, the flat rack tends to slide to the side of the trailer, dumping the cargo onto the ground. The GRK has side rollers that extend downward approximately six inches and interface with the outside edges of the trailer. When locked into the corner castings of the PLS flat rack the GRK prevents the flat rack from slipping either to the right or left as it is pulled rearward on the trailer. A Drag Sling Assembly is used to drag the front flat rack on the trailer to the rear where the LHS can engage the bail bar. Two brassboard models of the Guide Roller subassembly were fabricated at no cost to the Government and, when used in a field experiment, successfully removed the rear most flat rack from a trailer by use of the PLS LHS. It was not possible to remove the forward flat rack, as four Guide Roller subassemblies

would be required as well as some type of drag sling, none of which existed at the time. Three complete prototype Guide Roller Kits have been fabricated and are now available for demonstration and for conduct of limited field trials. Each GRK consists of six Guide Roller subassemblies and one drag sling subassembly.

2. Relevant Literature.

a. ASI Systems International Report 90-01, "Hooklift Interface Kit (HIK) Phase II Design Field Test Results," D.J. Shearin, Sr., March 1990.

b. ASI Systems International Report 90-02, "Phase II Design Intermodal Ammunition Container (AMCON) Field Test," D. J. Shearin, Sr., March 1990.

c. ASI Systems International Proposal 8902, "Enhancement of Palletized Loading System (PLS)," 28 September 1989.

d. TCATA Test Report FT490, "Palletized Loading System (PLS) Ammunition Distribution System," RCS ATTE-3, March 1987, TRADOC Combined Arms Test Activity, Fort Hood, Texas, 76544-5065.

e. DOT Report 99-46-UI-159, "Optimizing Wartime Materiel Delivery: An Overview of DoD Containerization Volume 1," Past Efforts and Current Issues, Donna Woodman, Joseph Coughlin, Michael Wolfe, October 1988.

II. OBJECTIVE

A. Classification of Research: Concept Demonstration Field Trials

B. Major Objective:

To provide a concept demonstration to the US Army of prototype hardware that will provide the PLS with a capability to offload two fully loaded PLS flat racks from the bed of an M872 34-1/2 ton trailer by using the Load Handling System (LHS) on the PLS. Following the concept demonstration, a limited number of Proof of Principal type timed trials will be conducted by USAHEL. The results of the contractor demonstration will be provided to the US Army

Human Engineering Laboratory as a technical report prepared by ASI in accordance with DI MISC 80711.

C. Benefits of Research/Testing:

Expansion of the Human Factors (HF) tech base and evaluation of equipment to provide further enhancements to the capability of the PLS.

III. METHODOLOGY

A. Participants:

Operation of the military equipment for the demonstration and conduct of limited Proof of Principal type field trials will be by military and civilian personnel assigned to the Logistics System Team, Combat Service Support Division, HEL. ASI Systems International will provide hands-on technical support and direction for conduct of the demonstration. Technical personnel from West Lake Corporation, a sub-contractor of ASI and the producer of the prototype hardware, will be on hand as observers and available for consultation with both ASI and Government representatives during the contractor pre-demonstration and final demonstration trials.

B. Responsibilities:

The ASI Technical Representative will be responsible for providing the prototype hardware and will prepare the Test Protocol and Field Test Plan for Conduct of contractor demonstration and limited Proof of Principal (POP) type field trials by HEL. The Government principal investigator will be responsible for supporting the ASI technical representative including the provision of GFE equipment and equipment operating personnel for conduct of the concept demonstration. He will also provide Test Personnel (TP) required for conduct of the limited, timed field trials. The Government principal investigator will also serve as on-site safety director with responsibility for insuring that the demonstration and follow-on field trials are conducted in accordance with applicable safety directives of the Aberdeen Proving Ground and the Human Engineering Laboratory.

C. Test Location:

The trials will be conducted at the HELFAST Logistics Technology Test Site, Edgewood Area, Aberdeen Proving Ground, MD or a comparable site in the Aberdeen Proving Ground area as may be designated by the COTR.

D. Apparatus:

1. Equipment to be Used in the Demonstration and Field Trials.
   - Prototype Guide Roller Kit (GRK)(three sets)
   - PLS vehicle
   - 34-1/2 ton, M872 Semi-trailer
   - 4000 pound capacity RTFL
   - Palletized inert and "dummy" ammunition
   - Stop watches and/or electronic data collection devices

   All equipment will be GFE with the exception of the GRK.

2. Precision of Equipment: All equipment used will be in operating condition.

3. Safety Features of the Equipment: The PLS vehicle has been used in military tests for several years and has been safety certified for military operations. The M872 Trailer and 6000 lb RTFLs are military standard. Two Guide Roller subassemblies of a similar design as those being used in the demonstration of the Guide Roller Kit were previously used by HEL personnel in trials without incident. All personnel operating PLS vehicles and RTFLs on site will be appropriately licensed. Safety procedures associated with the operation of the equipment such as the use of ground guides during operation of the RTFLs used in support of the trials will be enforced by the on site Government designated safety officer.

4. Field Test Layout: Figure 1 is a schematic of the HELFAST test site which shows the placement of items to be used in the testing of the GRK. Prior to start of the demonstration, an M872 trailer carrying two flat racks loaded with palletized ammunition will be parked on the dirt road. Three GRK roller subassemblies will be placed on the ground on each side of the trailer. The PLS vehicle, without a flat rack, will be backed to within approximately one to two feet of the rear end of the M872 trailer.

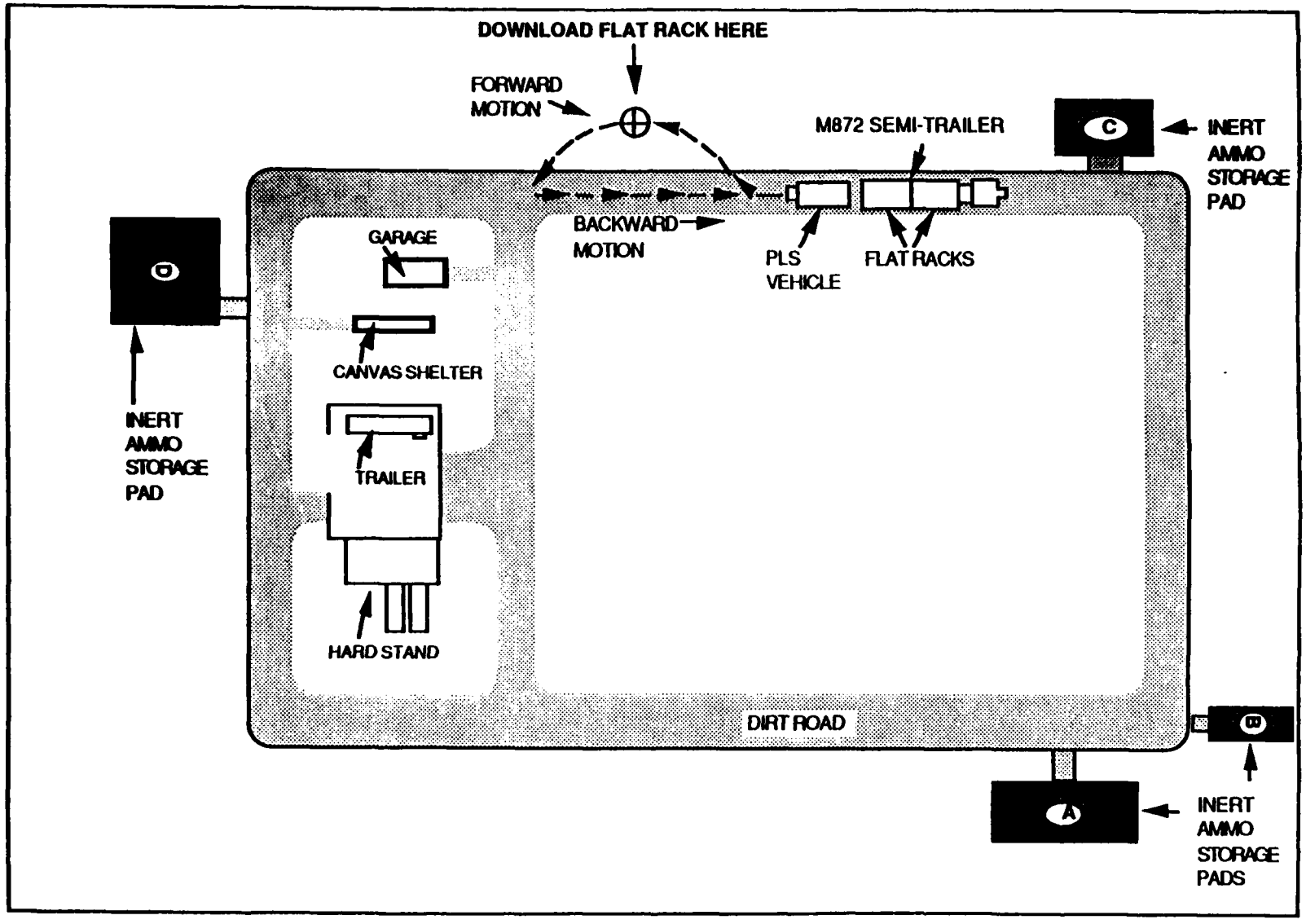


Figure 1. Schematic of Test Layout (HELFAST Test Site).

1. Briefing Procedures: All personnel participating in the test will be thoroughly briefed by the ASI technical representative and the Government principal investigator prior to the beginning of the demonstration and timed field trials. A question and answer approach will be used prior to the start of each subtest to assure that all the participants thoroughly understand what is to be accomplished.

2. Training and Training Assessment: Government personnel designated to operate the RTFLs and PLS vehicles will have previously been trained and appropriately licensed to operate the equipment. The ASI technical representative will go through a "dry run" to demonstrate what each trial will consist of including the procedure for fastening and releasing the Guide Roller subassemblies to and from the corner castings on the PLS flat rack and the functioning of the Drag Sling subassembly. Although the primary purpose of these trials is to demonstrate the feasibility of the concept of using the GRK in offloading PLS flat racks from a M872 trailer by use of the PLS Load Handling System, a limited number of timed trials will be performed in order to obtain basic performance data including soldier/equipment interface information.

3. Instructions:

a. A detailed test plan will be prepared and approved prior to the beginning of the field trials. The plan will include specific objectives, a schedule for conduct of the trials, identification of data to be recorded, and the number of trials to be performed by each designated team. Two 2-man teams, consisting of a PLS driver and assistant driver, are planned for conduct of the timed trials.

b. Pre-printed data sheets will be used to record the required data and will include such information as the Test Participants (TP) name and or identification number, time and date of the trial, time required to complete the trials, and narrative comments relative to the performance of the equipment. The primary interest is to determine whether the GRK can be used to safely transfer two flat racks loaded with ammunition from the bed of an M872 trailer onto the ground with the LHS of a PLS.

c. Since this is a materiel concept demonstration and Proof of Principal project, film and/or video tape coverage of some of the trials is planned to assist in the Government's evaluation of the GRK and for use in subsequent briefings, presentations and equipment demonstrations.

4. Data Collection: The primary purpose of the trials is to demonstrate the feasibility of a concept for transferring PLS flat racks loaded with palletized ammunition from an M872 trailer onto a PLS vehicle and thence onto the ground by use of the PLS LHS and to gather soldier/materiel interface information on the GRK. In order to facilitate the analytical process, each trial will be divided into three subfunctions. "Time start" and "time complete" will be recorded for each subfunction. A separate data form (See Appendix A) will be used for each trial. The data collection forms have been designed to include space for recording narrative statements dealing with the performance of the equipment with particular emphasis on equipment compatibility with the PLS and the soldier/equipment interfaces.

IV. EXPERIMENTAL DESIGN

A. Description of Independent, Dependent and Control Variables:

The independent variables for this demonstration and limited field trials are the test procedures, the test participants and test layout. The dependent variables to be measured during the concept demonstration and field trials are time and procedural errors. Time to perform each function will be recorded in the appropriate space shown on the form. Errors in procedure, and performance information relative to the performance of the GRK including its structural integrity, and the soldier/equipment interface information will be recorded in the "comment" section of the data collection sheet. These engineering and performance comments are of prime importance. Of particular concern will be the performance compatibility of the GRK with the PLS. Written comments based on observations are required to answer such questions as:

- How much time and how many persons are required to ready the flat racks for transloading from the M872 trailer to the PLS vehicle?
- Could the number of personnel and time required be reduced if the design of the GRK were changed?
- Is the structural integrity of the GRK adequate?
- Would the GRK perform more effectively if a second roller* were to be added to the under side of the Guide Roller subassembly where it interfaces with the floor of the trailer to reduce friction between the base of the PLS flat rack and the floor of the trailer?
- Do the side rollers on the roller subassembly of the GRK mate properly with the sides of the M872 trailer?

- What changes are recommended to improve the compatibility and performance capability of the GRK with the PLS and the M872 trailer?

*NOTE: ONE SET OF GUIDE ROLLERS HAS BEEN DESIGNED WITH TWO ROLLERS EACH, ONE TO INTERFACE WITH THE SIDE OF THE TRAILER AND ONE TO REDUCE FRICTION BETWEEN THE BOTTOM OF THE FLAT RACK AND THE FLOOR OF THE TRAILER. BOTH TYPES WILL BE TESTED DURING THE PRE-DEMONSTRATION TRIALS.

The layout of the test site will be held constant. Each flat rack will be loaded with an artillery combat configured load consisting of 15 pallets of 155mm projectiles banded in groups of three each, two pallets of red prop charges, one pallet of green prop charges and two pallets of white prop charges. All ammunition and prop charges will be inert.

Each trial is divided into three subfunctions as follows.

1. Subfunction #1 - Install Six GRK Roller Subassemblies. The driver will install one subassembly in each of the two corner castings on the left side of the flat rack located nearest the front of the trailer and one in the corner casting on the left rear of the flat rack located nearest the rear end of the trailer. The assistant driver will simultaneously install and secure roller subassemblies in the right side corner castings of the flat racks, opposite those installed by the driver. "Time Start" will be on signal from the time keeper. "Time Stop" will be recorded when the last roller subassembly has been installed and secured in place

2. Subfunction #2 - Transload One Flat Rack from an M872 Trailer onto a PLS and Place it on the Ground. The driver will lower the hook of the LHS until it is slightly below the bail bar on the PLS flat rack nearest the rear of the trailer. On signal from the time keeper and guided by hand signals from the assistant driver on the ground, the driver will engage the flat rack with the hook on the LHS and transfer the flat rack from the trailer to the PLS vehicle. When the rear of the flat rack is clear of the floor of the trailer, the assistant driver will signal the driver to stop. The assistant driver will disconnect the two Guide Roller subassemblies and then signal the driver to continue loading the flat rack. When loaded, the driver will drive the PLS vehicle forward approximately 50 ft to the right of the road, download the flat rack and return to his original position with the back of the PLS to within 1- to 2-ft of the rear of the trailer. "Time